A Manual for Basic Techniques of Data Analysis and Distribution

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A Manual for Basic Techniques of Data Analysis and Distribution

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(2014)

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Many Thanks to Almighty God, who is Merciful and Beneficent

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I would like to thank Dr. M. I. Subhani for helping me to write this manual. I also would like to thank my Parents, Teachers, Friends and the Rest of my family, who supported and encouraged me in spite of all the time it took me away from them. It was a long and difficult journey for them.

Thanks to Publications E-Servers - without you, this manual book would never find its way to the Web and to so many people who cannot read the printed form of manual book.

Last and not least; I beg forgiveness of all those who have been with me throughout the preparation of manual preparation and whose names I fail to mention.
Abstract

A manual is designed to support and help the basic concepts of statistics and its implications in econometric, beside this, interpretation of further statistical techniques have been shown as well by illustrations and graphical methods. It is comprised on several instances of test, obtained from statistical software like SPSS, E-views, Stata and R-language with the understanding of their research models and essentials for the running the test. A basic of manual is included on two elements, first is Distributions of data and second is techniques involve in data analysis. The first part considered the thoughtful meaning of data nature in statistical aspects whereas the other important part explained tactics incorporate with different sets of data and also concept of assimilation of tests in a form of flow chart. The factors have been identified through tests are associations, causes, effects, impacts, relations and integrations that belong to time series sets of observations. On the other hand, a review has been performed of non-time series statistics by introducing techniques in the form of list of tests. The most of the theme of manual is designed in bullets form in order to provide better understanding to reader for the purpose of analyses. Beside these, supported studies of famous authors have been reviewed; hence, technical terminologies of synonyms have been demonstrated in glossary section.
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ECONOMETRICS

- Econometrics is a branch of social science.
- Econometrics starts when statistics ends, and econometrics formed with the violation of statistics.
- Statistics does not tell exact interpretation of data whereas econometrics tells the exact interpretation of data.
- Empirical testing is best in econometrics.

Software for data analysis:

SPSS

R-language

E-views

Stata

Types Axioms:

- Rationality
- Convexity
- Continuity
- Revealed preference
- Random or stochastic

Types of data:

Time series data: if data is explaining time by time period.

Panel data: data is defining with respect to period. Panel data itself a time series data.

Cross sectional data: data is defining in one period of time.
Autocorrelation:

1) If we want to find autocorrelation in time series data then we use Durbin Watson test.

2) If we want to find autocorrelation in panel data then we use H-test.

In panel data we do not take out autocorrelation of panel data in statistics but in econometrics we use H-test.
Distribution:

Data

→ Parametric
  → Shapiro test (tells distribution)
    → (if test is non-sig then normal distribution)
      → It’s ok. Normal distribution is necessary in parametric data
        → (if test is sig then not normal distribution)
          → Transformation will be applied
            → For time series data: 1\textsuperscript{st} and 2\textsuperscript{nd} difference
              → For non-time series data: Arithmetic/Geometric

→ Non-parametric
  → K-Smirnov test (tells distribution)
    → (if test is non-sig then normal distribution)
      → Parametric test will be applied
        → (if test is sig then not normal distribution)
          → Non-parametric test will be applied

First we will find that data is parametric or non-parametric.

Observation of parametric data = 5kg, 25km/hrs, 60m\textsuperscript{3} etc (vector or unit is defined)

Observation of non-parametric ordinal data: 5,12,18,16,21 etc (vector is not defined)

For Non-parametric Data:
If data is non-parametric then we will apply k-Smirnov test. It will tell that data is normal distributed or not for non-parametric data. If value of test comes significant then data is not normal distributed and we can apply non-parametric test. And if value of test comes non-significant then data is normal distributed and we can apply parametric test.

For Parametric Data:
If data is non-parametric then we will apply Shapiro test. It will tell that data is normal distributed or not for parametric data. If value of test comes non-significant then data is normal distributed. If data is normal distributed then it’s ok and we will do nothing because normal distributed is necessary in parametric data. And if value of test comes significant then data is not normal distributed, so we will make data normal distributed by transformation method. If data is time series then we will apply arithmetic and geometric transformation for making data normal. If data is not time series then we will apply 1\textsuperscript{st} difference and 2\textsuperscript{nd} difference.

For distribution, first we will analyze data that is present in parametric form or non-parametric form. If data is parametric then normal distribution is necessary. If data is not normally distributed then we have to make data normal by using transformation. But if data is non-parametric then we will use K-Smirnov test. It will tell that data is normal or not but beside this it also tells that weather we will apply parametric test or non-parametric test.

If you are predicting something then your data will be normal.

If you are finding cause & affect then you data will be not normal.

Methodology will decide about our data that it is normal or not.

- For regression both variable are in normal distribution.
- For blues only dependent variable in normal distribution.
- For censored regression, dependent variable are non-parametric or semi parametric. We censored dependent variable so we censored its distribution.
- If we want to check shock/non-stationarity/oscillation/bombs in time series then no normal distribution data is required.
- If data found in normal distribution then we do spectral analysis/ de-trending by using trigonometric transformation in order to find shocks.
Transformation:

For making data in normal distribution we do transformation.

1) For making data normal in Non-time series data we use

   Arithmetic = square root / reciprocal

   Geometric = log

2) For making data normal in time series data we use

   1\textsuperscript{st} difference and 2\textsuperscript{nd} difference

   If any case 1\textsuperscript{st} difference and 2\textsuperscript{nd} difference is not able to investigate that means sure cannot be investigated.

3) For making data not normal in time series data we use

   Trigonometric transformation

   De-trending or Spectral analysis

4) For making data not normal in non-time series data we do not need to do anything because it would be already present in the form of not normal distribution.

Parametric & non-parametric:

- There is no need to check distribution of non-parametric data in statistics.

- We can check distribution of non-parametric data in econometrics.

- For parametric data we use Shapiro test.

  If its value comes significant then distribution is not normal.

- For non-parametric data we use keys 7 rock test.

  If its value comes significant then distribution is not normal.

  - If answer comes in not normal distribution then we apply non-parametric test.
  - If answer comes in normal distribution then we apply parametric test.
If data is non-parametric nominal it means, it’s a categorical data so we can’t investigate its distribution.

If data is non-parametric ordinary then we can investigate its distribution. We apply K-Smirnov test then we check that either we should apply parametric test or non-parametric test.

**Specification Error:**

Specification error can be identified by literature support not by econometrical test or econometrics.

Specification error is found in model, and sometimes in data as well.

1) If we add any irrelevant variable in model or we did not add any relevant variable in model then it become specification error.

   Eg: \( y = a + b_1x_1 + b_2x_2 + ET \)  \( X_3 \) is not included

   \( X_2 \) is irrelevant or \( X_3 \) is relevant

2) If single log is required and we have taken double or semi log, if double log is required and we have taken single or semi log, if semi log is required and we have taken single or double log.

   Eg: \( \log y = a + b_1\log x_1 + b_2\log x_2 + ET \)

   Single log is required

3) If we formed only single equation but model required two equations or if we formed two equation and model required on single equation.

   Eg: \( y = a + bx \)

   \( Y = a + bx + ET \)

   Only one equation is required
4) If model should be OLS and you have made scaled OLS means you took wrong model.
   Eg: we have to introduce lag variable, mean we are finding out current GDP from
   previous GDP data and we have applied ADF model but ARLD model is required.

5) If the relationship is studied then model should not be deterministic.
   Eg: it should be stochastic because we are doing research in social science but not in pure
   science.

6) Model required variable with relative value while model has variable with absolute value.
   Eg: income in % = a +b (expenditure Rs25000)
   Expenditure should also in %

7) If co-linearity exists between both independent variables then we transform any one
   variable, not both. If we transform both variables then it becomes specification error.

8) Specification error includes taking variable in wrong form.
   Eg: house hold expense = a + b salary
   We should take house hold income instead of salary because it will define better
   relation.

9) Co-linearity is the specification error.
   Eg: both independent variables are correlated with each other.

10) If DV and IV are same then it is also specification error.
   Eg: expo is in front of civic center and civic center is in front of expo. So address can’t be
   defined.

11) If you run wrong test then it also includes in specification error.

12) Presence of type 1 and type 2 errors in research is considered as specification error.
13) Data was required in normal distribution and you took not normal data or vice versa then it is specification error.

14) If model requires linear association and you have taken non-linear then its specification error.

**Presence of Outlier:**

- **Outlier** = observation of data which are not following a trend.
- Outliers disturb arithmetic mean.
- **Z =** more than 3.384 then observation is significant outlier.
- Grubbs test (which is in R language) helps to find out exact number of outlier in data by giving Z value of each observation.
- If we delete outliers there will be two issue:
  1) Sample size would reduce.
  2) Sample will become biased.
- There are two ways to get rid of outliers. One is to dissolve them or either eliminates them.
- For dissolving: We do log transformation for dissolving outliers. It will make the Z value of observation is 1. Something so due to this observation of outlier comes under normal observation.
- For eliminating: if outlier comes from human error so it should be eliminated.

**Sample Size of Data:**

- If data is non-parametric then population is infinite so sample size will be around 280 – 380.
- If data is parametric and not time series then sample size at least 30 observations.
Eg: 30 years, 30 countries, 30 months

- If data is parametric and time series then sample size should be 60 +
- Sample size and sample unit are different. (Sample size: 300 student, sample unit: 5 universities)

**Co-linearity and Multi-co-linearity:**

If relationship exist between two independent variable then co-linearity exist in each other.

Eg:

1) \( DV = a_1 + b_1 \text{IV}_1 + b_2 \text{IV}_2 + ET \)  
   if \( \text{IV}_1 \) & \( \text{IV}_2 \) have relation then co-linearity exist

2) \( DV = a_1 + b_1 \text{IV}_1 + b_2 \text{IV}_2 + b_3 \text{IV}_3 + ET \)  
   if \( \text{IV}_1, \text{IV}_2, \text{IV}_3 \) have relation then multi-co-linearity exist

Due to co-linearity independent variables can’t explain dependent variable completely so its an issue.

Co-linearity increases ET so:

Cause: presence of co-linearity

Effect: increase in ET

So if we have idea about effect means ET so we can conclude cause means co-linearity.

**Indication of co-linearity:**

Gardge magnitude: increase, (husky), around 1000

Gatrade magnitude: increase

Tolerance: decrease

Adjusted R square: non-significant, increase, more than 0.9

F value: non-significant, less than 3.84

VIF= more than 2
VIF is inversely proportional to tolerance.

**Solution to fixed co-linearity:**

Co-linearity in variables is the specification error.

There are 2 solutions to resolve co-linearity:

1) Transformation method:

- We do transformation to create dissimilarity, so we do transformation any one variable.
- If the issue of co-linearity is not resolve by transformation then we do double transformation.
- The original data and accurate information loss by transformation and research can be biased, so the best method is substitution.
- In substitution method, it removes co-linearity without transform the data.

2) Substitution method:

\[ Y = a + b_1x_1 + b_2x_2 + ET \]

After run model, model will be:

\[ Y = a + b_1x_1 + b_2x_2 \quad ------ \text{eq 1} \]

If VIF value comes more than 2 then \( x_1 \) and \( x_2 \) are co-linear with each other.

Where, \( x_1 = a + b_3x_2 \quad ------ \text{eq 2} \)

\[ X_2 = a + b_4x_1 \quad ------ \text{eq 3} \]

Putting these two equations in eq 1 then add both, so we will:

\[ Y = 0.5a_5 + 0.5a_7 + 0.5b_6x_2 + 0.5b_8x_1 \]

So the value of \( b_1 \) and \( b_2 \) were same. Now both have change to \( b_6 \) and \( b_8 \). So co-linearity has resolved.
Statement of Falsification:

- A statement which denies, revamp or make it doubtful existing hypothesis, principle, theory and law is called statement of falsification.
- It also helps in extracting assumptions.
- If specification error present in model then hypothesis can be challenged through statement of falsification.
- If statement of falsification accepts then it cut it off the theory from root.
  If statement of falsification rejects then it revalidate of theory.
- Assumption can be formed in theory in order to get rid of from statement of falsification.
- How many assumptions are present in theory, it tells number of statement of falsification came against theory.

Reason of statement of falsification:

1) Specification error
2) Observation
3) Logical reasoning
4) Literature support
5) Violation of axiom
6) Presence of type errors

Eg:

Theory: Brand awareness explains intention to purchase.

SOF: Brand equity does not explain intention to purchase.
Techniques Involve In Data Analysis:

1) If two trends are associated then we check cross correlation between them.
2) If two equations/expressions are associated then we check co-integration.
3) If two variables are associated then we check correlation.
4) If two observations are associated then we check auto correlation.
5) If two independent variables are associated then we check co-linearity.
6) If two dependent variables are associated then we check sure.
7) For transforming dependent variable we use blues.
8) For finding the non-correlated objects we use sure investigate.
9) Sure tells hidden relation.

Time Series Econometrics:

If data is time series then we apply time series econometrics.

Time series researches are found in large number as compare to non-time series researches.

Time series researches are mostly found in finance and economic and sometimes in marketing.

A thing should be appropriate in which you are using data.

Coefficients:

- The coefficient of regression is beta (β)
- The coefficient of correlation is the coefficient of correlation
- The coefficient of auto correlation is Rho
- The coefficient of auto regression is Rho
- The coefficient of co-integration is Log-Likelihood
ADF-test/ADF unit root test:

ADF is the abbreviation of Augment Degree Fuller.

1) This test checks non-stationarity, shocks, bombs and oscillation in time series data.
2) Beside this it also tells that shocks are temporary or permanent.
3) It tells that is there any room to correct error term.
4) It tells that when we will apply ECM (Error Correction Model).

ADF test explains that is data in unit root or not means what is ADF t value and relation with Micron critical value. It tells comparison of ADF correspondence t value with MicKinnon critical value.

(Variation) having small wavelength

(Shocks) having large wavelength

Two questions:

1) Why shocks are present in data?

   \textbf{Answer}: Variation in data, means shocks in data come on the basis of time and place. Means observation changes time by time and place by place. If data is changing by time so it is time series data. So it is necessary in time series data that variation will come by time because time is changing automatically.

2) Why should we investigate them?
**Answer:** We have main concern about change of value neither absolute value that is why we analyze variation in data. Eg: We do not concern, what is share price of today but we have concern that what will be share price of tomorrow and the day after tomorrow.

In e-view software, Test critical is Micron critical value.

If ADF-test value is greater than Micron critical value then presence of non-stationarity.

If ADF-test value is less than Micron critical value then presence of stationarity.

ADF model is being made in OLS frame work.

**Eg:**

\[ \Delta Y_t = aY_{t-1} + x't + B_1 \Delta Y_{t-1} + ET_t \]

Alpha value  
-0.00963  
1.562  
0.38  

T-value  
[-1.1337]  
[1.4066]  
[5.91420]

Taken from Dr. Subhani’s research: Information management and business review. Vol 2 no.6 pp.246-251, june 2011. (Monetary shocks or real shocks)

**Notation:**

- \( a \) = root / absolute value of share
- \( \Delta \) = delta / change in share price
- \( B \) = beta tells the change
- \( X' \) = Exogenous Regressor = correction of error term and included in model
- \( ET \) = error term
- \( Y_{t-1} \) = previous period observation

**Findings:**

1) ADF > MCV

Presence of non-stationarity.

2) Co-efficient of augmented diecky fuller test is 1 or more
Shocks are permanent.

3) t-value of C is 1.5 or more (significant)

Model has a room to correct error term and ECM may be applied to correct error term.

4) Confirmation test: prob or p-value is more than 0.05 (non-significant)

Presence of non-stationarity.

Software information:

For current lag means zero order and “t”

Lag 1 = t-1 and Lag 2 = t-2

1) (Open file) C\program files\SPSSInc\statistics17\samples\English\broadband_1. (run)

2) (Eliminate) year, date and month.

3) (Go to) Quick, series statistics, unit root test.

4) Insert column for consideration.

5) (Select) level, Schwarz info criterion, intercepts, maximum lag = 10.

Example#1:

<table>
<thead>
<tr>
<th>Augmented Dickey-Fuller Unit Root Test on MARKET_1</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-0.936347</td>
<td>0.7826</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.548208</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-2.912631</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-2.594027</td>
<td></td>
</tr>
</tbody>
</table>


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MARKET_1)
Method: Least Squares
Date: 11/20/11 Time: 17:18
Sample (adjusted): 3 60
Included observations: 50 after adjustments

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARKET_1(-1)</td>
<td>-0.0045689</td>
<td>0.005008</td>
<td>-0.936347</td>
<td>0.3532</td>
</tr>
<tr>
<td>D(MARKET_1(-1))</td>
<td>0.037802</td>
<td>0.134788</td>
<td>0.2506162</td>
<td>0.0152</td>
</tr>
<tr>
<td>C</td>
<td>-1.232986</td>
<td>44.868993</td>
<td>2.753946</td>
<td>0.0078</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared</td>
<td>0.114775</td>
<td>Mean dependent var</td>
<td>132.8127</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>69.00680</td>
<td>Akaike info criterion</td>
<td>11.87912</td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>44.16364</td>
<td>Schwarz criterion</td>
<td>11.98570</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-341.4944</td>
<td>Hannan-Quinn criter.</td>
<td>11.92064</td>
</tr>
<tr>
<td>F-statistic</td>
<td>3.565562</td>
<td>Durbin-Watson stat</td>
<td>2.069954</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prob(F-statistic)</th>
<th>0.034992</th>
</tr>
</thead>
</table>
Findings:

1) ADF test value > MCV

\[-0.93 > -2.59 , -2.91 , -3.54\] at 1% , 5% , 10%

Presence of non-stationarity

2) Coefficient of ADF = -0.004689 < 1

Shocks are temporary

3) t-value of C = 2.763946 > 1.5 (significant)

Model has a room to correct error term and ECM may be applied to correct error term.

4) Confirmation test: prob = 0.7696 (insignificant)

Presence of non-stationarity

5) Model:

\[\Delta M_{1t} = \alpha M_{1t-1} + \delta X_t + \Delta M_{1t-1} + \varepsilon_t\]

\[
\begin{array}{ccc}
-0.0046 & 123.2966 & 0.3378 \\
[-0.936] & [2.763] & [2.506]
\end{array}
\]

Example#2:

**Augmented Dickey-Fuller Unit Root Test on D(TOTAL)**

Null Hypothesis: D(TOTAL) has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic based on AIC, MAXLAG=10)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob. *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>0.145387</td>
</tr>
</tbody>
</table>

Test critical values:
- 1% level: -3.565430
- 5% level: -2.919952
- 10% level: -2.597905


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TOTAL),2
Method: Least Squares
Date: 11/20/11 Time: 18:26
Sample (adjusted): 1060
Included observations: 51 after adjustments

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(TOTAL,-1)</td>
<td>0.007984</td>
<td>0.054916</td>
<td>0.145387</td>
</tr>
<tr>
<td>D(TOTAL,-1.2)</td>
<td>-0.518730</td>
<td>0.152524</td>
<td>-3.400975</td>
</tr>
<tr>
<td>D(TOTAL,-2.2)</td>
<td>-0.193619</td>
<td>0.166944</td>
<td>-1.160479</td>
</tr>
<tr>
<td>D(TOTAL,-3.2)</td>
<td>0.070819</td>
<td>0.163786</td>
<td>0.469024</td>
</tr>
<tr>
<td>D(TOTAL,-4.2)</td>
<td>-0.248211</td>
<td>0.162103</td>
<td>-1.531198</td>
</tr>
<tr>
<td>D(TOTAL,-5.2)</td>
<td>-0.431348</td>
<td>0.173952</td>
<td>-2.376543</td>
</tr>
<tr>
<td>D(TOTAL,-6.2)</td>
<td>-0.579869</td>
<td>0.182701</td>
<td>-3.217543</td>
</tr>
<tr>
<td>D(TOTAL,-7.2)</td>
<td>-0.482668</td>
<td>0.180428</td>
<td>-2.675075</td>
</tr>
</tbody>
</table>

R-squared: 0.392705
Adjusted R-squared: 0.277030
S.E. of regression: 1779.255
Sum squared resid: 1.336e+98
Log likelihood: 449.0963
F-statistic: 3.304891
Prob(F-statistic): 0.924301
Findings:

1) ADF test value > MCV
   
   $$1.45 > -2.59 , -2.91 , -3.56 \text{ at 1\% , 5\% , 10\%}$$

   Presence of non-stationarity

2) Coefficient of ADF = 0.007984 < 1

   Shocks are temporary

3) t-value of C = 0.483602 < 1.5 (insignificant)

   Model does not has a room to correct error term.

4) Confirmation test: prob = 0.9662 (insignificant)

   Presence of non-stationarity

5) Model: $\Delta M_{1t} = \alpha M_{1t-1} + \delta X_t + \Delta M_{1t-1} + ET$
   
   $-0.0046 \quad 123.2966 \quad 0.3378$

   $[-0.936] \quad [2.763] \quad [2.506]$
**Auto Regressive Lag Distribution Model (ARLD Model):**

In OLS or regression model, if lag variable of dependent variable is introduced then model become ARLD model. (OR) If lag variable is introduced in model and it regress dependent variable then model is ARLD.

Why we called its Auto Regressive Lag Distribution model?

Because lag variable is distributed in model and dependent variable is regress with its lag.

If dependent variable is regress with its lag then its mean that auto regression is present.

OLS model:  \[ DV = \alpha + \beta IV + ET \]

ARLD model:  \[ DV = \alpha + \beta_1 IV + \beta_2 DV_{t-1} + ET \] therefore, \(DV_{t-1}\) is a lag variable

<table>
<thead>
<tr>
<th>Year</th>
<th>(X_t)</th>
<th>(X_{t-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>2010</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>2009</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>2008</td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>2007</td>
<td>27</td>
<td>29</td>
</tr>
<tr>
<td>2006</td>
<td>29</td>
<td>31</td>
</tr>
<tr>
<td>2005</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td>2004</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

\(X_{t-1}\) = lag variable and \(X_{t+1}\) = log variable

\(X_{t-1}\) = lag variable of previous year

\(X_{t-2}\) = lag variable of previous to previous year

\(X_{t-3}\) = lag variable of previous to previous to previous year
**Vector Auto Regression (VAR) and Auto Regression (AR):**

1) If Stationarity is present in one time series data then AR is applied.

2) If Stationarity is present in two or more time series data. In which first is dependent variable and second is independent variable then IV is predicting DV, so VAR is applied.

If non-stationarity is present in 2 or more non-time series data then we apply regression and OLS model.

ADF model must be applied before applying VAR & AR because ADF tells non-stationarity in time series data.

1) DV = α + β1lag1DV + ET (ARLD for AR)

2) DV = α + β1lag1DV + β2lag2DV + β3lag1IV + β4lag2IV + ET (ARLD for VAR)

In both equation, model is ARDL and econometrics is VAR and AR

1) If DV is regress with its previous lag variable then ARLD model is for AR.

2) If DV is regress with its previous lag variable and as well as previous lag variable of other variable then ARLD model is for VAR.

1) For 1 time series = AR is applied

2) For 2 or more time series = VAR is applied

X, Y is absolute value

\( \triangle X, \triangle Y \) is relative value

1) In AR we use absolute term

\[ X = \alpha + \beta_1 \text{lag}_1X + ET \]

2) In VAR we use relatives & absolute term both

\[ X = \alpha + \beta_1 \text{lag}_1X + \beta_2 \text{lag}_2X + \beta_3 \text{lag}_1Y + \beta_4 \text{lag}_2Y + ET \]

\[ \triangle X = \alpha + \beta_1 \text{lag}_1 \triangle X + \beta_2 \text{lag}_2 \triangle X + \beta_3 \text{lag}_1 \triangle Y + \beta_4 \text{lag}_2 \triangle Y + ET \]
1) We apply AR in SPSS-13

2) We apply VAR in e-views

1) Example for AR:

In spss-13. (Open file) C/program files/SPSSInc/statistics17/samples/English/broadband_1. (run)

Then analyze, time series, auto correlation

Select DV = market_1 & IV = market_2

Select Prais-winsten then OK

Auto regression = auto correlation

Durbin Watson = around 2 means no auto correlation

Durbin Watson = Less than 2 means positive auto correlation.

Durbin Watson = More than 2 means negative auto correlation.

Durbin Watson tells the sign of Rho. Weather it is positive or negative.

Rho tells the association between current lag & previous lag.

In regression β is coefficient and in auto regression Rho is coefficient.

Rho is a coefficient of lag1 DV.

Good model: Durbin Watson ~ Rho

ARLD is applied if auto correlation is present and Durbin Watson is significant.

If t-value comes 1.5 or more, then it’s significant. That mean, its coefficient and its variable are also significant.

If Rho = zero then ARLD model can not apply. That mean, there is no coefficient of previous lag variable.

ARLD model can apply, if auto correlation is present and DW is significant.

In final Iteration DW must be less than 2.
Iteration 7

**Autocorrelation Coefficient**

<table>
<thead>
<tr>
<th>Rho (AR1)</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>.944</td>
<td>.044</td>
</tr>
</tbody>
</table>

The Prais-Winsten estimation method is used.

**Model Fit Summary**

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.081</td>
<td>.776</td>
<td>.768</td>
<td>127.960</td>
<td>1.028</td>
</tr>
</tbody>
</table>

The Prais-Winsten estimation method is used.

**ANOVA**

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>32341.21</td>
<td>1</td>
<td>32341.20825</td>
</tr>
<tr>
<td>Residual</td>
<td>933308.76</td>
<td>57</td>
<td>16373.838</td>
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</table>

The Prais-Winsten estimation method is used.

**Regression Coefficients**

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td></td>
<td>Beta</td>
</tr>
<tr>
<td>Subscribers for Market 2 (Constant)</td>
<td>.165</td>
<td>.012</td>
<td>.881</td>
<td>14.054</td>
</tr>
<tr>
<td></td>
<td>2354.574</td>
<td>449.517</td>
<td></td>
<td>5.238</td>
</tr>
</tbody>
</table>

The Prais-Winsten estimation method is used.

**Findings:**

1) Rho = 0.944. That means, if IV (increase in 1 unit) then DV (increase in 0.944 units)

2) DW = 1.028. Less than 2. That mean, significant and there is positive autocorrelation b/w DV and its lag.

3) DW = 1.028. Less than 2. That mean, the sign of Rho is also positive. (i.e. Rho = +0.944)

4) Rho is not in (△) delta form. So here it is showing absolute value, not relative value.

5) Model:

   \[ DV = \alpha + \beta_1 \text{lag1DV} + \beta_2 \text{IV} + ET \]

   \[ M_1 = \alpha + \beta_1 \text{lag1M1} + \beta_2 \text{M2} + ET \]
6) Intercept and market 2 are significant, having t-value significant. While previous lag of market 1 is insignificant.

7) Market 2 and intercept significantly predicting market 1.

8) Intercept is significant. That mean, there is some value of intercept. And if we make zero all other IV then there will be some value of DV.

2) Example for VAR:

VAR is present in absolute & relative term both.

Significant = predicting

[ ] = t-statistics value

( ) = standard error

Without bracket = coefficient

If t-value comes 1.5 or more, then it’s significant. That mean, its coefficient and its variable are also significant.

If f-value come 3.84 or more, then it’s significant. That mean, R square, model and corresponding variable is also significant.

If the magnitude of f-value is too large then associations between variables is long term and if magnitude comes close to 3.84 but more than 3.84 then associations between variables is short term.

Schwarz SC > Akaike A/C = Schwarz criteria is used

Schwarz SC < Akaike A/C = Akaike criteria is used

ET = 1 – R square
Findings:

1) Variables are showed in absolute form. Because there is no sign of delta (△) with variables. (i.e market_1 & market_2)

2) Market_1 is taken to be consideration b/c our DV is market_1

3) Model:

\[ X = \alpha + \beta_1 \text{lag1}X + \beta_2 \text{lag2}X + \beta_3 \text{lag1}Y + \beta_4 \text{lag2}Y + \text{ET} \]

\[ M_1 = \alpha + \beta_1 \text{lag1}M_1 + \beta_2 \text{lag2}M_1 + \beta_3 \text{lag1}M_2 + \beta_4 \text{lag2}M_2 + \text{ET} \]

<table>
<thead>
<tr>
<th>Alpha value</th>
<th>309.25</th>
<th>1.20</th>
<th>-0.29</th>
<th>-0.02</th>
<th>0.03</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-value</td>
<td>(3.85)</td>
<td>(8.86)</td>
<td>(-2.3)</td>
<td>(-0.83)</td>
<td>(1.33)</td>
</tr>
</tbody>
</table>

4) Lag1M1, lag2M2 are significant and lag1M2, lag2M2 are not significant.
5) Previous year lag1 & lag2 of M1 are predicting DV but lag1 & lag2 of M2 are not predicting DV that’s why it come in the category of AR not VAR. Because DV is regressing with its previous year lags but not other variable lags.

6) Intercept is significant. That means, if all IV come zero then there will be some value of DV. Mean intercept has some value.

7) In SPSS-13 Rho was 0.94. In e-views 1.2. (So 0.94 ~ 1.2)

8) Adjusted R square = 0.99. That means, if DV is 99% predicted by the model.

9) F-value = 10926.42. That means, association between variables is long term. In other words, association of lag1M1 and lag2M1 with M1 is long term.

10) Magnitude of Schwarz SC > magnitude of Akaike A/C. Which means that Schwarz criteria is applied.
Unidirectional/Bidirectional Causality:

Two variables can predict in not time series. Regression is used whether it is bi-variant or multi-variant.

Two variables can cause in time series. A variable which causes, should be in previous lag and a variable which is caused, should be in current lag.

Xt-1 effecting Yt Unidirectional

Xt-1 effecting Yt & Yt-1 effecting Xt Bidirectional

1) For unidirectional, Granger causality test is used.

2) For bidirectional, Cross correlation test is used.

1) The purpose of Granger causality test is to investigate unidirectional causality.

2) The purpose of Cross correlation test is to investigate bidirectional causality.

Unidirectional Causality:

Granger Causality Test: (testing unidirectional causality)

Model will be in OLS frame work and intercept is not present in model.

Yt = βXt-1 + ET or

Yt = βXt-2 + ET or

Yt = βXt-3 + ET

ET is present in every model:

It is not an ARLD model because lag variable is of IV and not of DV. So it is OLS frame work.

Why intercept is not present in model?

Reason:

If IV = 0 then DV = intercept.
Necessary condition = Cause = Cloud

Sufficient condition = Effect = Rain

1) Variable that addressed first = IV and variable that addressed after that = DV

2) Cause addressed first and effect addressed after that.

Without cause, effect is impossible whereas without IV, DV is zero.

So if IV = zero then DV = zero because there is no effect without cause.

There is no possibility of presence of intercept, if IV is zero.

**Example:**

In e-views (Open file) C/program files/SPSSInc/statistics17/samples/English/broadband_1. (run)

Quick, group statistics, granger causality test.

Put market_1 space market_2

Select lag 1

1) Acceptance of Null hypothesis is more than 5% of p-value.

2) Acceptance of alternate hypothesis is less than 5% of p-value.

<table>
<thead>
<tr>
<th>Pairwise Granger Causality Tests</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date: 12/04/11     Time: 17:16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample: 1 60       Lags: 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Null Hypothesis:</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARKET_2 does not Granger Cause MARKET_1</td>
<td>59</td>
<td>6.08897</td>
<td>0.0167</td>
</tr>
<tr>
<td>MARKET_1 does not Granger Cause MARKET_2</td>
<td>0.43324</td>
<td>0.5131</td>
<td></td>
</tr>
</tbody>
</table>

**Findings:**

1) Null hypothesis:

   a) Market_2 does not Granger Cause market_1 (reject)

   b) Market_1 does not Granger Cause market_2 (accept)
2) Alternate hypothesis:
   a) Market_2 does Granger Cause market_1 (accept)
   b) Market_1 does Granger Cause market_2 (reject)
3) Result:
   a) Lag 1 of market_2 is significantly cause to market_1
   b) Lag 1 of market_1 is not significantly cause to market_2
4) Lag = sample (N) – Obs
   Lag = 60 -59
   Lag = 1 (therefore, Granger Causality is investigated for lag 1)
   Test took lag 1 of IV.
5) Model:
   Yt = βXt-1 + ET
   M1 = βM2t-1 + ET
   f-value: (6.088)

**Expected Question in Exam:**

Yt = βXt-1 + ET

= (f=6.088)

= N=60

= N of IV = 58

Granger Causality is investigated in which lag?

**Answer:** 60 – 58 = lag 2
**Bidirectional Causality:**

Partial auto regression and simple partial auto regression investigate non-stationarity in data.

They also tell that whether we should apply cross correlation or not.

**In unidirectional causality:**

X predicts Y (forward biased or reverse biased) irreversible reaction

Y predicts X (forward biased or reverse biased) irreversible reaction

Both are not predicting each other at a same time.

Unidirectional investigate 1 direction in 1 time.

**In bidirectional causality:**

X predicts Y and Y predicts X (reversible reaction) both are predicting each other at a same time

Bidirectional investigate 2 directions at a time.
J-BOX Q-Statistics method for PAC & SPAC:

Durbin Watson shows an autocorrelation in time series data.

H-test shows an autocorrelation in panel data.

J-box Q-statistics is used to investigate partial auto regression and simple partial auto regression in time series data and panel data.

Durbin Watson just tells that auto correlation is present or not but J-box Q-statistics tells that which lag is predicting current observation.

J-box Q-statistics tells categorically each observation about each lag.

Xt-1 is predicting Y (auto correlation)

Frame work of J-box Q-statistics of auto correlation.

<table>
<thead>
<tr>
<th>X</th>
<th>Xt-1</th>
<th>Xt-2</th>
<th>Xt-3</th>
<th>Xt-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Number of lags = Number of observations – 1

Q. Should we include intercept in model?

If all IV is zero then DV and α will be 1st value of DV i.e. (1)

Therefore intercept should be present in model.

Co-linearity is investigated among IV and Auto correlation is investigated in DV only due to intercept. (α)
1st value of DV can’t be zero because it is scale data. Zero value does matter in categorical data but there will be no observation of zero value in scale data.

\[ X_t = \alpha + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \beta_n X_{t-n} + \epsilon_t \]

Here magnitude of \( \alpha \) is the 1st value of DV.

There are two events come in J-box Q-statistics those indicate the stationarity in data and autocorrelation.

1) Cutoff event = auto correlation varies immediately. It shows temporary relation.

2) Dicing event = auto correlation decrease gradually in lags. It shows permanent relation.

These events should be present b/c we want auto correlation.

ADF and PAC investigate non-stationarity in data.

**Example:**

In SPSS-17 (Open file) C\text{/}program files\text{/}SPSSInc\text{/}statistics17\text{/}samples\text{/}English\text{/}broadband_1. (run)

Analyze, forecasting, autocorrelation

Click on autocorrelation and partial autocorrelation.

**If data was panel:** Then we select option & do click on (display autocorrelation at periodic lag)

If two time series is present and autocorrelation is present b/w those for same lag so chances of presence of bidirectional causality.
For market 1:

### Autocorrelations

<table>
<thead>
<tr>
<th>Lag</th>
<th>Autocorrelation</th>
<th>Std. Error</th>
<th>Box-Ljung Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.354</td>
<td>0.128</td>
<td>57.432</td>
</tr>
<tr>
<td>2</td>
<td>0.365</td>
<td>0.125</td>
<td>110.091</td>
</tr>
<tr>
<td>3</td>
<td>0.353</td>
<td>0.124</td>
<td>157.451</td>
</tr>
<tr>
<td>4</td>
<td>0.359</td>
<td>0.123</td>
<td>199.892</td>
</tr>
<tr>
<td>5</td>
<td>0.748</td>
<td>0.122</td>
<td>237.481</td>
</tr>
<tr>
<td>6</td>
<td>0.334</td>
<td>0.120</td>
<td>269.372</td>
</tr>
<tr>
<td>7</td>
<td>0.542</td>
<td>0.119</td>
<td>332.613</td>
</tr>
<tr>
<td>8</td>
<td>0.592</td>
<td>0.118</td>
<td>324.724</td>
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<tr>
<td>9</td>
<td>0.541</td>
<td>0.117</td>
<td>345.078</td>
</tr>
<tr>
<td>10</td>
<td>0.492</td>
<td>0.115</td>
<td>354.051</td>
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<tr>
<td>11</td>
<td>0.443</td>
<td>0.115</td>
<td>370.533</td>
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<tr>
<td>12</td>
<td>0.334</td>
<td>0.114</td>
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<tr>
<td>13</td>
<td>0.347</td>
<td>0.112</td>
<td>400.489</td>
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<tr>
<td>14</td>
<td>0.301</td>
<td>0.111</td>
<td>407.799</td>
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<td>15</td>
<td>0.254</td>
<td>0.109</td>
<td>413.148</td>
</tr>
<tr>
<td>16</td>
<td>0.212</td>
<td>0.107</td>
<td>418.335</td>
</tr>
</tbody>
</table>

- **Box-Ljung Statistic**: Value, df, Sig.

- **Sig.**
  - a. The underlying process assumed is independence (white noise).
  - b. Based on the asymptotic chi-square approximation.

### Subscribers for Market 1

![Graph showing autocorrelation and box-ljung statistic](image-url)
Partial Autocorrelations

<table>
<thead>
<tr>
<th>Lag</th>
<th>Partial Autocorrelation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.354</td>
<td>129</td>
</tr>
<tr>
<td>2</td>
<td>-.062</td>
<td>129</td>
</tr>
<tr>
<td>3</td>
<td>-.156</td>
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</tr>
<tr>
<td>4</td>
<td>-.077</td>
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</tr>
<tr>
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</tr>
<tr>
<td>6</td>
<td>-.012</td>
<td>129</td>
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<tr>
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<td>129</td>
</tr>
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<td>-.029</td>
<td>129</td>
</tr>
<tr>
<td>12</td>
<td>-.028</td>
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<td>129</td>
</tr>
<tr>
<td>16</td>
<td>-.032</td>
<td>129</td>
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</tbody>
</table>

For market 2

Auto correlations

<table>
<thead>
<tr>
<th>Lag</th>
<th>Autocorrelation</th>
<th>Std. Error</th>
<th>Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.055</td>
<td>.129</td>
<td>0.568</td>
</tr>
<tr>
<td>2</td>
<td>.113</td>
<td>.125</td>
<td>0.550</td>
</tr>
<tr>
<td>3</td>
<td>.337</td>
<td>.124</td>
<td>0.335</td>
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<td>4</td>
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<td>.123</td>
<td>0.335</td>
</tr>
<tr>
<td>5</td>
<td>.779</td>
<td>.122</td>
<td>0.122</td>
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<td>.779</td>
<td>.122</td>
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<td>0.116</td>
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<td>.116</td>
<td>0.116</td>
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<td>.404</td>
<td>.115</td>
<td>0.404</td>
</tr>
<tr>
<td>14</td>
<td>.404</td>
<td>.115</td>
<td>0.404</td>
</tr>
<tr>
<td>15</td>
<td>.404</td>
<td>.115</td>
<td>0.404</td>
</tr>
<tr>
<td>16</td>
<td>.404</td>
<td>.115</td>
<td>0.404</td>
</tr>
</tbody>
</table>

a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.

(1st Edition) 38
Findings:

1) In Partial Autocorrelation cutoff event is present in charts of market 1 & 2 so stationarity is present in both markets.

2) Market 1 and market 2 are significant for 16 lags.

3) Significant lags are same for market 1 & 2, graphs are also same (i.e. cutoff). So bidirectional causality is investigated and we can apply cross correlation.

4) Cutoff event is indicating temporary relation between variables.
Cross correlation:

<table>
<thead>
<tr>
<th>Lag</th>
<th>Cross Correlation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>-7</td>
<td>.477</td>
<td>.137</td>
</tr>
<tr>
<td>-6</td>
<td>.719</td>
<td>.136</td>
</tr>
<tr>
<td>-5</td>
<td>.766</td>
<td>.135</td>
</tr>
<tr>
<td>-4</td>
<td>.819</td>
<td>.134</td>
</tr>
<tr>
<td>-3</td>
<td>.865</td>
<td>.132</td>
</tr>
<tr>
<td>-2</td>
<td>.899</td>
<td>.131</td>
</tr>
<tr>
<td>-1</td>
<td>.943</td>
<td>.130</td>
</tr>
<tr>
<td>0</td>
<td>.983</td>
<td>.129</td>
</tr>
<tr>
<td>1</td>
<td>.944</td>
<td>.136</td>
</tr>
<tr>
<td>2</td>
<td>.897</td>
<td>.131</td>
</tr>
<tr>
<td>3</td>
<td>.847</td>
<td>.132</td>
</tr>
<tr>
<td>4</td>
<td>.798</td>
<td>.134</td>
</tr>
<tr>
<td>5</td>
<td>.746</td>
<td>.135</td>
</tr>
<tr>
<td>6</td>
<td>.586</td>
<td>.135</td>
</tr>
<tr>
<td>7</td>
<td>.344</td>
<td>.137</td>
</tr>
</tbody>
</table>

Based on the assumption that the series are not cross correlated and that one of the Series is white noise.

Findings:

1) Column of cross correlation is showing cross correlation between both variables i.e. market1 & 2

2) Maximum prediction is on lag 0

3) There are no cross correlation b/w variables.

4) White noise = ET

ET is present any one of the series. That can be market 1 or 2.
5) It always comes with chart that present of white noise in data which proves that it is not an axiom.

6) In future prediction and forecasting, cause will be decrease in future.

7) Lag 5 of market 1 is predicting 76.5% of current variable of market 2 and lag 5 of market 2 is predicting 76.5% of current variable of market 1.
Co-Integration:

Co-integration means co-movement.

If co-integration is significant so it means that both series are exclusively move in a same direction with each other. In other words co-movement is present in both series.

Mackinnon critical value 5% is P-value.

Types

1) Johnson co-integration
   a) Bi-variant
   b) Multi-variant

2) VAR based co-integration. (application of VAR)

3) ECM based co-integration. (application of ECM)

Bi-Variant:

If we investigate test in pair form then we will use Bi-Variant.

If T-statistics > Mackinnon Critical value

Presence of non-stationarity

Log-likely hood is a coefficient of co-integration.

Example:

In e-views (Open file) C/program files/SPSSInc/statistics17/samples/English/broadband_1. (run)

Quick, group statistics, co-integration

Write market_1 (space) market_2

At MHM Mackinnon critical value is 5%

We have to select Osterwald Lenun for random basis. Means 1% and 5%
Findings:

1) Trace statistics = t-statistics = t-value < Mackinnon critical value (at None)
   
   There is no co-integration

2) Max-Eigen statistics = confirmation test
   
   t-value < Mackinnon critical value (at None)
   
   There is no co-integration

3) Both are not co-moving & non-stationarity is present in different order

4) Chance of co-integration at different order is more than same order.

Multi-Variant:

If we investigate test in joint form then we will use Multi-Variant.

If T-statistics > Mackinnon Critical value
Presence of non-stationarity

Log-likelihood is a coefficient of co-integration.

**Example:**

In e-views (Open file) C/program files/SPSSInc/statistics17/samples/English/broadband_1. (run)

Quick, group statistics, co-integration

Write `market_1` (space) `market_2` (space) `market_3`

Now we will select MHM for Mackinnon critical value 5%

### Johansen Cointegration Test

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>0.05 Critical Value</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.257573</td>
<td>26.79046</td>
<td>29.7907</td>
<td>0.1069</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.137464</td>
<td>9.516281</td>
<td>15.49471</td>
<td>0.3198</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.016065</td>
<td>0.933351</td>
<td>3.841466</td>
<td>0.3324</td>
</tr>
</tbody>
</table>

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level  
**MacKinnon-Haug-Michellis (1999) p-values

### Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue</th>
<th>Max-Eigen Statistic</th>
<th>0.05 Critical Value</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.257573</td>
<td>17.27418</td>
<td>21.13162</td>
<td>0.1595</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.137464</td>
<td>8.576930</td>
<td>14.26460</td>
<td>0.3231</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.016065</td>
<td>0.933351</td>
<td>3.841466</td>
<td>0.3324</td>
</tr>
</tbody>
</table>

Max-eigenvalue test indicates no cointegration at the 0.05 level  
* denotes rejection of the hypothesis at the 0.05 level  
**MacKinnon-Haug-Michellis (1999) p-values

**Findings:**

1) At None* = co-integration b/w market_1 and market_2
At most 1* = co-integration b/w market_1 and market_3

At most 2* = co-integration b/w market_2 and market_3

There is no star at any hypothesized. So there is no co-integration b/w variables.

2) Trace statistics = t-statistics = t-value < Mackinnon critical value (at all level)

So co-integration has not been found

3) Max-Eigen statistics = confirmation test

    t-value < Mackinnon critical value (at all level)

    There is no co-integration

Q. why do we call error is white noise?

Error means resistance or noise and white color is the combination of all color. So when all errors are combined so it becomes white noise. In other words “merger and aggregation of error is called white noise”.

Example:

Table 1: Augmented Dickey-Fuller (ADF) Unit Root Test:

<table>
<thead>
<tr>
<th>VARIABLES / SERIES</th>
<th>ADF TEST WITH INTERCEPT &amp; TREND AT SAME ORDER</th>
<th>ADF TEST WITH INTERCEPT &amp; TREND AT 1ST DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADF COEF</td>
<td>T-STAT</td>
</tr>
<tr>
<td>Stock Prices of KSE 100-Index</td>
<td>-0.000226</td>
<td>-0.53938</td>
</tr>
<tr>
<td>Stock Prices of BSE Sensex</td>
<td>-4.45E-05</td>
<td>-0.08453</td>
</tr>
<tr>
<td>Stock Prices of DSE Composite</td>
<td>-0.001420</td>
<td>-0.82841</td>
</tr>
<tr>
<td>Stock Prices of Nepal SEExchange</td>
<td>-0.000172</td>
<td>-0.33944</td>
</tr>
<tr>
<td>*Mackinnon Critical Values (5008 Observations)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>-3.43</td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>-2.86</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>-2.56</td>
<td></td>
</tr>
</tbody>
</table>
Findings:

1) Data of four stock exchanges has been taken.
   
   Karachi, Bombay, Dhaka, and Nepal

2) T-statistics > Mackinnon Critical value

   Presence of non-stationarity.

3) Now we will investigate co-integration among variables

   **Table 2: Johansen Multivariate Co-integration Test among the Stock Prices of KSE 100, BSE Sensex, DSE Composite, and Nepal SE indices**

<table>
<thead>
<tr>
<th>VARIABLES / SERIES</th>
<th>LOG-LIKELIHOOD</th>
<th>T-STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock Prices of KSE 100, BSE Sensex, DSE, and NSE Indices</td>
<td>-82748.16</td>
<td>50.507080</td>
</tr>
<tr>
<td>Mackinnon Critical Values (5008 Observations)</td>
<td>1% 54.46</td>
<td>5% 47.21</td>
</tr>
</tbody>
</table>

   **Table 3: Johansen Bi-variate Co-integration Test between the Stock Prices of KSE 100-Index & rest of equity markets on 1 on 1 basis**

<table>
<thead>
<tr>
<th>VARIABLES / SERIES</th>
<th>LOG-LIKELIHOOD</th>
<th>T-STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock Prices of KSE 100-Index &amp; Bombay Stock Exchange Sensex</td>
<td>-42408.20</td>
<td>11.374460</td>
</tr>
<tr>
<td>Stock Prices of KSE 100-Index &amp; Dhaka Stock Exchange Composite</td>
<td>-42899.62</td>
<td>15.620252</td>
</tr>
<tr>
<td>Stock Prices of KSE 100-Index &amp; Nepal Stock Exchange</td>
<td>-38299.68</td>
<td>11.228000</td>
</tr>
<tr>
<td>Mackinnon Critical Values (5008 Observations)</td>
<td>1% 20.04</td>
<td>5% 15.41</td>
</tr>
</tbody>
</table>

Findings:

1) Co-integration has been found at 5% among all variables in multi-variate co-integration test

2) Co-integration has been found at 5% b/w KSE & Dhaka Stock Exchange in Bi-variate co-integration test

3) There is no co-integration b/w KSE & Bombay, KSE & Nepal in Bi-variate
4) Log-Likelihood is a co-efficient of co-integration

The equations of KSE & Dhaka Stock Exchange are associated with co-efficient (-42899.62)
**Error Correction Model: (ECM) or Granger Representation Theorem:**

It explains the correction of error in model of association of variables.

- **Time series data (at least 2)**
- **Non-stationarity at zero/same order & stationarity at not zero order**
- **Exogenous regressor is significant for both series**

**ECM**

If we have at least 2 time series data then we check non-stationarity at zero/same order and stationarity at not zero order (can be at 1st difference = 1st lag) and exogenous regressor is also significant then we will apply ECM.

Exogenous regressor indicates clearly that weather we will apply ECM or not.

Another school of thought is: non-stationarity in time series is an issue, so it should be fixed. So fixing of non-stationarity is called stationarity.

**Example:**

In e-views (Open file) C\program files\SPSSInc\statistics17\samples\English\broadband_1. (run)

Quick, VAR, click on Vector error correct

Write market_1 (space) market_2

If f-statistic is significant (means more than 3.84) then error has been corrected and findings have come after correction. But if f-statistic is not significant then we will not accept values of 2nd chart.

- **t-value = trace value = significant when t-value>1.5 (weather +ve or –ve)**

CointEq1 = equation of market_1 current lag

[ ] = t-statistics value

( ) = standard error
### Vector Error Correction Estimates

**Date**: 12/25/11  **Time**: 16:55  
**Sample (adjusted)**: 460  
**Included observations**: 57 after adjustments  
**Standard errors in () & t-statistics in []**

<table>
<thead>
<tr>
<th>Cointegrating Eq:</th>
<th>CointEq1</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARKET_1(-1)</td>
<td>1.000000</td>
</tr>
<tr>
<td>MARKET_2(-1)</td>
<td>-0.173134</td>
</tr>
<tr>
<td></td>
<td>(0.00833 )</td>
</tr>
<tr>
<td></td>
<td>[-20.7776 ]</td>
</tr>
<tr>
<td>C</td>
<td>-2173.939</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Error Correction:</th>
<th>D(MARKET_1)</th>
<th>D(MARKET_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CointEq1</td>
<td>-0.104501</td>
<td>0.130622</td>
</tr>
<tr>
<td></td>
<td>(0.03209)</td>
<td>(0.14498)</td>
</tr>
<tr>
<td></td>
<td>[-3.25635 ]</td>
<td>[ 0.90112 ]</td>
</tr>
<tr>
<td>D(MARKET_1(-1))</td>
<td>0.234602</td>
<td>-0.283161</td>
</tr>
<tr>
<td></td>
<td>(0.13011)</td>
<td>(0.58770)</td>
</tr>
<tr>
<td></td>
<td>[ 1.80311 ]</td>
<td>[-0.48181 ]</td>
</tr>
<tr>
<td>D(MARKET_1(-2))</td>
<td>0.222309</td>
<td>-0.579494</td>
</tr>
<tr>
<td></td>
<td>(0.13597)</td>
<td>(0.61413)</td>
</tr>
<tr>
<td></td>
<td>[ 1.63497 ]</td>
<td>[-0.94353 ]</td>
</tr>
<tr>
<td>D(MARKET_2(-1))</td>
<td>-0.039881</td>
<td>0.450989</td>
</tr>
<tr>
<td></td>
<td>(0.03135)</td>
<td>(0.14162)</td>
</tr>
<tr>
<td></td>
<td>[-1.27199]</td>
<td>[ 3.24800 ]</td>
</tr>
<tr>
<td>D(MARKET_2(-2))</td>
<td>-0.014173</td>
<td>0.180992</td>
</tr>
<tr>
<td></td>
<td>(0.03342)</td>
<td>(0.15095)</td>
</tr>
<tr>
<td></td>
<td>[-0.42410 ]</td>
<td>[ 1.19902 ]</td>
</tr>
<tr>
<td>C</td>
<td>108.8391</td>
<td>398.6571</td>
</tr>
<tr>
<td></td>
<td>(36.8868)</td>
<td>(166.616)</td>
</tr>
<tr>
<td></td>
<td>[ 2.95063 ]</td>
<td>[ 2.39267 ]</td>
</tr>
</tbody>
</table>

| R-squared | 0.284784 | 0.286744 |
| Adj. R-squared | 0.214665 | 0.215817 |
| Sum sq. resid | 351628.0 | 7174223. |
| S.E. equation | 83.03413 | 375.0614 |
| F-statistic | 4.061421 | 4.100613 |
| Log likelihood | -329.66069 | -415.5537 |
| Akaike AIC | 11.77568 | 14.79136 |
| Schwarz SC | 11.99074 | 15.00642 |
| Mean dependent | 134.2944 | 726.9841 |
| S.D. dependent | 93.69772 | 423.8095 |

| Determinant resid covariance (dof adj.) | 9.54E+08 |
| Determinant resid covariance | 7.63E+08 |
| Log likelihood | -744.6782 |
| Akaike information criterion | 26.62029 |
| Schwarz criterion | 27.12209 |
Findings:

1) First part shows a model without correction.

2) Second part indicates the values after correction.

3) F-statistic is significant for both variable (i.e. market_1 & market_2)

4) By t-value: 1st difference of market_1 is predicted by cointEg1, 1st difference of market_1 lag 1, 1st difference of market_1 lag 2. And intercept. Whereas it is not predicted by 1st difference of market_2 lag 1 and 1st difference of market_2 lag 2.

5) By t-value: 1st difference of market_2 is predicted by 1st difference of market_2 lag 1 and intercept. Whereas it is not predicted by cointEg1, 1st difference of market_1 lag 1, 1st difference of market_1 lag 2 and 1st difference of market_2 lag 2.

Endogeneity:

It is measureable.

If any relevant variable did not include in model then it is called ignored variable and it is will be include in ET. If that ignored variable is co-linear with any IV so due to this ET will also co-lineant with that IV.

Qd = α – β1(P) + β2(Y) + ET

Now if: ignored variable = quality =Q

Quality is measureable so its endogeneity. And we will apply Heckman regression.

If we apply Hacksman regression and in comes insignificant then it means that error term comes from exogenity.

Exogenity:

It is not measureable.
If any relevant variable did not include in model then it is called ignored variable and it is will be include in ET. If that ignored variable is co-linear with any IV so due to this ET will also co-lineant with that IV. 

\[ Q_s = \alpha - \beta_1(P) + \beta_2(\text{quality}) + \text{ET} \text{ (Production of fruit)} \]

Now if: ignored variable = Sunlight

Sunlight is not measureable so its exogenity. And we can’t apply any test on it. It can’t be measureable b/c its variable is not measureable.

We can apply ECM only on endogenity.
**Sum Up All Tests:**

```
Time series →
<table>
<thead>
<tr>
<th>Stationarity</th>
<th>non-stationarity (zero order)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAR</td>
<td>Co-integration</td>
</tr>
<tr>
<td>Granger Causality</td>
<td>ECM</td>
</tr>
<tr>
<td>VED</td>
<td>Impulse behavior</td>
</tr>
</tbody>
</table>
```

**For Stationarity**

1) **Stationarity**: If data is time series then we will apply ADF URT. If bumps are not present then stationarity is present. Weather it is on same order or 1\textsuperscript{st} difference or 2\textsuperscript{nd} difference.

2) **VAR**: If stationarity is present then we will apply VAR. VAR predicts, and it is significant when PAC tells cutoff & dicing.

VAR: Tells previous lag of 1\textsuperscript{st} series is predicting the 2\textsuperscript{nd} series current lag and previous lag of 2\textsuperscript{nd} series is predicting the 1\textsuperscript{st}.

For one lag = AR and for may lags VAR (P) order

3) **Granger Causality**: If VAR is significant then chance of present of granger causality. It causes not predicts.

4) **VED**: If granger causality is present then we investigate VED (variance error decomposition) on a series which is caused.
It can tell can we minimize SD or can we minimize the difference b/w mean of ET – lag observation of ET.

VED: it tells that weather we can decompose variance of error term or not.

\[
\text{Variance} = (S.D)^2 = (\text{mean of ET} - \text{lag observation of ET})
\]

5) **Impulse Analysis:** If VED is significant then we apply impulse behavior or impulse analysis.

Any minor change is impulse behavior. Visible change = cutoff = bumps

**For Non-Stationarity**

1) **Non-stationarity:** If data is time series then we will apply ADF URT. If bums are present then non-stationarity is present.

2) **Co-integration:** If non-stationarity is present in 2 or more time series data then we investigate co-integration.

   If non-stationarity is on zero order then co-integration is confirmed 100%
   If non-stationarity is on same order then co-integration is confirmed 50%
   If non-stationarity is on different order then co-integration is confirmed 0%

3) **ECM:** Beside this if exogenous regressor is significant as well then we apply ECM also.

   The concept of unidirectional and ECM is given by granger so the other name of ECM is granger representation theorem.
Non-Time Series Econometrics:

Prediction and application of regression:

For prediction = OLS model is used & regression is used as econometric technique.

IV = fixed / same

DV = random

IV is same every time means prediction is not accurate and change every time.

Y = α + β X

3 = α + β (2)

6 = α + β (2)

14 = α + β (2)

Types of regression:

➤ On the basis of linearity or non-linearity.

1) Linear Regression

a) Simple linear regression (SLR)

b) Multiple linear regression (MLR)

c) GLM

d) Logit (multi-nominal regression)

 e) Probit (dichotomus regression)

f) Categorical regression/Optimal scaling

g) Tobit

h) Hecksman regression

i) Partial regression
2) **Curvi-linear Regression**

   a) Exponential regression (equations are depend on number of derivatives taken)

   b) Quadratic regression (having 2 equations)

   c) Cubical regression (having 3 equations)

**Exponential Regression:**

\[ DV = \alpha + IV1^{[\beta1]} + IV2^{[\beta2]} \]

1\(^{st}\) derivative = 1\(^{st}\) equation

2\(^{nd}\) derivative = 2\(^{nd}\) equation

3\(^{rd}\) derivative = 3\(^{rd}\) equation

➢ **On the basis of model:**

1) **OLS model (ordinary least square)**

   a) Simple linear regression (SLR)

   b) Multiple linear regression (MLR)

   c) GLM

   d) Logit (multi-nominal regression)

   e) Probit (dichotomus regression)

   f) Categorical regression/Optimal scaling

   g) Hecksman regression

   h) Exponential regression

   i) Quadratic regression

   j) Cubical regression

2) **SOLS model (Scaled ordinary least square)**

   a) Tobit
3) WLS (weighted least square)
   a) Partial Regression
References:


**Synonyms Glossary:**

Critical value = significant value

Spectral analysis = de-trending

Optimal scaling = linier scaling = categorical regression

Censored regression = propid

Curvi-linier regression = non-linier regression

Non-parametric nominal data = categorical data

Non-stationarity = oscillation = bumps = shocks
Few recommended books for more knowledge about Econometrics

Mohsin Hassan Alvi

Bachelor of Commerce
University of Karachi, Karachi, Pakistan

Master of Business Administration (Marketing & Finance)
Iqra University, Main Campus, Karachi, Pakistan